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Claims

WHAT IS CLAIMED IS:

1. A sampling probe for delivering a reactant to a substance deposited on a substrate to form a reaction product and for transporting the reaction product to a product analyzer for analysis, the probe comprising a tip positionable over the substance on the substrate, a recess in the tip sized and shaped for receiving at least a portion of the reaction product, a product sampling passage extending from the recess adapted for connection to the product analyzer for transporting at least a portion of the reaction product to the product analyzer, and a reactant delivery passage extending to an outlet positioned outside the recess for delivering reactant to the substance on the substrate to form the reaction product.

2. A probe as set forth in claim 1 further comprising a barrier surrounding said area outside the recess for reducing emission of reactants and reaction products beyond the barrier.

3. A probe as set forth in claim 1 wherein the probe includes a resiliently compliant element.

4. A probe as set forth in claim 3 wherein the resiliently compliant element comprises a bellows.

5. A probe as set forth in claim 1 further comprising a vent passage extending from an inlet positioned at the tip outside the recess for removing reactant from an area outside the

recess, said reactant delivery passage outlet being positioned
5 between the recess and the vent passage.

6. A probe as set forth in claim 1 in combination with
a scanning mass spectrometer, said product analyzer comprising
the spectrometer.

7. A method for sampling reaction products, said
method comprising the steps of:

delivering a reactant through the sampling probe set
forth in claim 1 to contact a substance deposited on a substrate;
5 reacting the reactant to form a reaction product;
withdrawing at least a portion of the reaction product
through the sampling probe; and
analyzing the withdrawn portion of the reaction
product.

8. A sampling probe for delivering a reactant to a
substance deposited on a substrate to form a reaction product and
for transporting the reaction product to a product analyzer for
analysis, the probe comprising a tip positionable over the
5 substance on the substrate, a recess in the tip sized and shaped
for receiving at least a portion of the reaction product, a
reactant delivery passage extending through the probe to an
outlet positioned at the tip for delivering reactant to the
substance on the substrate to form the reaction product, a
10 product sampling passage extending from the recess adapted for
connection to the product analyzer for transporting at least the
portion of the reaction product to the product analyzer, and a

barrier surrounding the area outside the recess for reducing emission of reaction products beyond the barrier.

9. A probe as set forth in claim 8 further comprising a vent passage extending from an inlet positioned outside the recess at the tip for removing reactant an area outside the recess.

10. A probe as set forth in claim 8 in combination with a scanning mass spectrometer, said product analyzer comprising the spectrometer.

11. A method for sampling reaction products, said method comprising the steps of:

delivering a reactant through the sampling probe set forth in claim 8 to contact a substance deposited on a substrate;
reacting the reactant to form a reaction product;
withdrawing at least a portion of the reaction product through the sampling probe; and
analyzing the withdrawn portion of the reaction product.

12. A sampling probe for delivering a reactant to a substance deposited on a substrate to form a reaction product and for transporting the reaction product to a product analyzer for analysis, the probe comprising an inner body and an outer body having an inner cavity sized and shaped for receiving the inner body, the inner body including a tip for engaging the substrate and having a recess sized and shaped for receiving at least a portion of the reaction product, a reactant delivery passage

extending through the probe to an outlet at the tip for
10 delivering reactant to the substance on the substrate to form the
reaction product, and a product sampling passage extending from
the recess adapted for connection to the product analyzer for
transporting at least the portion of the reaction product to the
product analyzer.

13. A probe as set forth in claim 12 wherein the inner
body includes a resiliently compliant element.

14. A probe as set forth in claim 13 wherein the
resiliently compliant element comprises a bellows.

15. A probe as set forth in claim 12 wherein the
reactant delivery passage has an annular section defined by an
exterior surface of the inner body and an interior surface of the
outer body.

16. A probe as set forth in claim 12 further
comprising a vent passage extending through the outer body from
an inlet positioned outside the recess of the tip for removing
reactant from an area outside the recess.

17. A probe as set forth in claim 12 in combination
with a scanning mass spectrometer, said product analyzer
comprising the spectrometer.

18. A method for sampling reaction products, said
method comprising the steps of:

delivering a reactant through the sampling probe set forth in claim 12 to contact a substance deposited on a substrate;

5 reacting the reactant to form a reaction product;
withdrawing at least a portion of the reaction product through the sampling probe; and
analyzing the withdrawn portion of the reaction
10 product.

19. A sampling probe for delivering reactants to a substance deposited on a substrate to form a reaction product and for transporting the reaction product to a product analyzer for analysis, the probe comprising a tip positionable over the substance on the substrate, a mixing chamber positioned inside the probe for mixing reactants therein, a plurality of reactant source passages extending through the probe from a plurality of reactant sources to the mixing chamber for delivering reactants to the mixing chamber, a reactant delivery passage extending from the mixing chamber to an outlet positioned at the tip for delivering reactants from the mixing chamber to the substance on the substrate thereby forming the reaction product, a recess in the tip sized and shaped for receiving at least the portion of the reaction product, and a product sampling passage extending from the recess adapted for connection to the product analyzer for transporting at least the portion of the reaction product to the product analyzer.

20. A probe as set forth in claim 19 wherein the probe includes a body having an inner cavity extending outward to an

opening in the body and a plug positioned in the opening to block the opening and thereby form the mixing chamber.

21. A probe as set forth in claim 20 wherein the reactant delivery passage extends through said plug.

22. A probe as set forth in claim 21 further comprising a cover mounted on the body covering the plug and forming a cavity between the cover and the plug, and an aperture extending through the cover to permit reactants to pass through the cover to the substance, wherein said aperture is offset from the reactant deliver passage in the plug to promote mixing of the reactants in the cavity.

23. A method for sampling reaction products, said method comprising the steps of:

delivering a reactant through the sampling probe set forth in claim 19 to contact a substance deposited on a substrate;

reacting the reactant to form a reaction product;

withdrawing at least a portion of the reaction product through the sampling probe; and

analyzing the withdrawn portion of the reaction product.

24. A sampling probe for delivering a reactant to a substance deposited on a substrate to form a reaction product and for transporting the reaction product to a product analyzer for analysis, the probe comprising a body, a tip positionable over the substance on the substrate, a resiliently compliant element

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10 positioned between the tip and the body for permitting the tip to move relative to the body, a recess in the tip sized and shaped for receiving at least a portion of the reaction product, a product sampling passage extending from the recess adapted for connection to the product analyzer for transporting at least a portion of the reaction product to the product analyzer, and a reactant delivery passage extending to an outlet positioned at the tip for delivering reactant to the substance on the substrate to form the reaction product.

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25. A probe as set forth in claim 24 wherein the resiliently compliant element comprises a bellows.

26. A probe as set forth in claim 24 further comprising a vent passage extending from an inlet positioned on the body for removing reactant.

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27. A probe as set forth in claim 26 wherein the vent passage inlet is positioned at the tip for removing reactant from an area outside the recess.

28. A probe as set forth in claim 24 further comprising an overflow vent passage in fluid communication with the recess for removing excess reactant from the recess.

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29. A probe as set forth in claim 24 in combination with a scanning mass spectrometer, said product analyzer comprising the spectrometer.

30. A method for sampling reaction products, said method comprising the steps of:

delivering a reactant through the sampling probe set forth in claim 24 to contact a substance deposited on a substrate;

reacting the reactant to form a reaction product;

withdrawing at least a portion of the reaction product through the sampling probe; and

analyzing the withdrawn portion of the reaction product.

31. A sampling probe for delivering a reactant to a substance deposited on a substrate to form a reaction product and for transporting the reaction product to a product analyzer for analysis, the probe comprising a body, a tip connected to the body and engageable with the substrate, a recess in the tip sized and shaped for receiving at least a portion of the reaction product, a product sampling passage extending from the recess adapted for connection to the product analyzer for transporting at least a portion of the reaction product to the product analyzer, and a reactant delivery passage extending to an outlet positioned at the tip for delivering reactant to the substance on the substrate to form the reaction product, wherein the tip includes at least one opening permitting reactants to flow into the recess when the tip engages the substrate.

32. A probe as set forth in claim 31 further comprising a resiliently compliant element connecting the tip to the body for permitting the tip to move relative to the body.

33. A probe as set forth in claim 32 wherein the resiliently compliant element comprises a bellows.

34. A probe as set forth in claim 31 further comprising a vent passage extending from an inlet positioned on the body for removing reactant.

35. A probe as set forth in claim 31 further comprising an overflow vent passage in fluid communication with the recess for removing excess reactant from the recess.

36. A probe as set forth in claim 31 in combination with a scanning mass spectrometer, said product analyzer comprising the spectrometer.

37. A method for sampling reaction products, said method comprising the steps of:

delivering a reactant through the sampling probe set forth in claim 31 to contact a substance deposited on a substrate;

reacting the reactant to form a reaction product;

withdrawing at least a portion of the reaction product through the sampling probe; and

analyzing the withdrawn portion of the reaction product.

38. A sampling probe for delivering a reactant to a substance deposited on a substrate to form a reaction product and for transporting the reaction product to a product analyzer for analysis, the probe comprising a body, a tip connected to the

5 body and engageable with the substrate, a recess in the tip sized
and shaped for receiving at least a portion of the reaction
product, a product sampling passage extending from the recess
adapted for connection to the product analyzer for transporting
at least a portion of the reaction product to the product
10 analyzer, a reactant delivery passage extending to an outlet
positioned at the tip for delivering reactant to the substance
on the substrate to form the reaction product, and an overflow
vent passage in fluid communication with the recess for removing
excess reactant from the recess.

39. A probe as set forth in claim 38 further
comprising a resiliently compliant element connecting the tip to
the body for permitting the tip to move relative to the body.

40. A probe as set forth in claim 39 wherein the
resiliently compliant element comprises a bellows.

41. A probe as set forth in claim 38 in combination
with a scanning mass spectrometer, said product analyzer
comprising the spectrometer.

42. A method for sampling reaction products, said
method comprising the steps of:

delivering a reactant through the sampling probe set
forth in claim 38 to contact a substance deposited on a
5 substrate;

reacting the reactant to form a reaction product;

withdrawing at least a portion of the reaction product
through the sampling probe; and

analyzing the withdrawn portion of the reaction
10 product.

43. A method for sampling reaction products, said method comprising the steps of:

delivering a reactant through a sampling probe to
contact a substance deposited on a substrate;

5 reacting the reactant to form a reaction product;

withdrawing at least a portion of the reaction product
through the sampling probe;

contacting the sampling probe with the substrate during
at least a portion of the delivering, reacting and withdrawing
10 steps; and

analyzing the withdrawn portion of the reaction
product.

44. A method as set forth in claim 43 wherein the
probe is contacted with the substrate for less than about 2
minutes during the delivering, reacting and withdrawing steps.

45. A method as set forth in claim 44 wherein said
substance is a first substance of a plurality of substances
deposited in an array on the substrate, and the steps of
delivering, reacting, withdrawing, contacting and analyzing are
5 performed sequentially for each of the substances deposited on
the substrate.

46. A method as set forth in claim 43 wherein the
reactant has a contact time with the substance of greater than
1 second.

47. A method as set forth in claim 46 wherein the reactant has a contact time with the substance of between about 2 seconds and about 10 seconds.

48. A method for sampling reaction products, said method comprising the steps of:

delivering a reactant through a sampling probe to contact a substance deposited on a substrate;

reacting the reactant to form a reaction product, the reactant having a contact time with the substance of greater than 1 second;

withdrawing at least a portion of the reaction product through the sampling probe; and

analyzing the withdrawn portion of the reaction product.

49. A method as set forth in claim 48 wherein the reactant has a contact time with the substance of between about 2 seconds and about 10 seconds.